

Barriers to Improve Productivity in Manufacturing Department: With Special Reference to the Behavioral Aspect of the Changeover Time

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ABSTRACT

Among the number of issues a manufacture faces at present, productivity is one of the significant issue. The study focuses on the productivity problem of a department of a leading manufacturing in Sri Lanka, which produces personal products such as shampoo toothpaste, cream etc. The loss time analysis revealed number of factors which adversely affect productivity of the selected department. The changeover time is one of them and research attempts to identify the barriers to improve productivity by analyzing behavioral factors that influence the high changeover time. Finally research suggests solution to rectify the barriers which adversely affect the changeover time and thereby increase the productivity.

KEYWORDS: Behavioral factors, Changeover time, Productivity, Personal Product manufacturing

INTRODUCTION

There are so many issues in manufacturing industry such as productivity, quality, environment, financial so on. Here it concerns one of the major issues in industry, productivity. In manufacturing sector, they try to improve their productivity in many ways. They try to improve the productivity mainly by increasing the production. To increase production, companies increase the capital that they invest, reduces wastages, improve the performances of machines, make the workplace a productive environment, achieve the safety environment and safety behaviors in work place and give incentive payments to the workers. Also with good leadership, an organization can overcome many issues. By that it can enhance the productivity very easily. The attitudes of workers highly affect the productivity in an organization.

During set up and adjustment time there is no production occurred. Thus that directly affects the productivity. To meet competitiveness in the market, the organization must regularly change their products from one to another. Therefore there should be done necessary adjustment for the machines. Thus setup and adjustment time should minimize as possible. Therefore setups or changeover time is major problem in improving productivity in the manufacturing organizations.

In multiproduct manufacturing environment the changeover is becoming very important. It is now recognized that any business where a range of products is to be manufactured on non dedicated equipment should be conscious of its change over capability. Therefore multiproduct environments should be understood the importance of improving changeover performance. In this situation awareness of changeover issues and awareness of what better changeover might contribute to business performance is needed.

A department in one of the leading manufacturing company in World that manufactures personal products is facing productivity problems mainly with high changeover time. This manufacturing company is a world spread multinational company, which is manufacturing fast moving consumer goods. Today it is home to 20 strong brands. The company was commissioned in 1938 and it operates in three sites. This Personal Product (PP) department is the largest department in the site. It is manufacturing and packing more than 26 products under 7 brands with 51 SKUs (Stock Keeping Units). The department is divided into two sections as manufacturing section and filling and packing section. The PP department is manufacturing shampoo, toothpaste, cream, dish wash and hand wash.

Total Productivity Maintenance (TPM) is a productivity technique that implemented in the company in 2006. The TPM in the company because of inefficient of productivity, working individually and no team work, low machine efficiencies, dirty, dangerous machines, lack of motivation and commitment and Poor reliability. The PP department evolves with the TPM and initially introduced the 5S to the department and other pillars of TPM too. A kaizen event under the continuous improvement pillar had reduced changeover time in NM700 model line. With TPM the PP department created pleasant environment to work, workers were highly motivated and achieved its production targets. At that

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time Overall Equipment Efficiency (OEE) of the department was around 75%- 80%.

However, now the PP department is facing severe problems with the production targets and productivity. The current OEE of the department reduce up to average 50%. According to the Figure 1.2 the main down type is the no demand. No demand indicates the low plans and no plans. Therefore it cannot be controlled by the pp department. The second major down type is equipment failures and they are spread on a vast area. Therefore analyzing those data covers a large area and it is necessary to have a specialized knowledge of mechanical and electrical engineering. Setup and adjustment time is the next highest effective factor of the performance of the pp department.

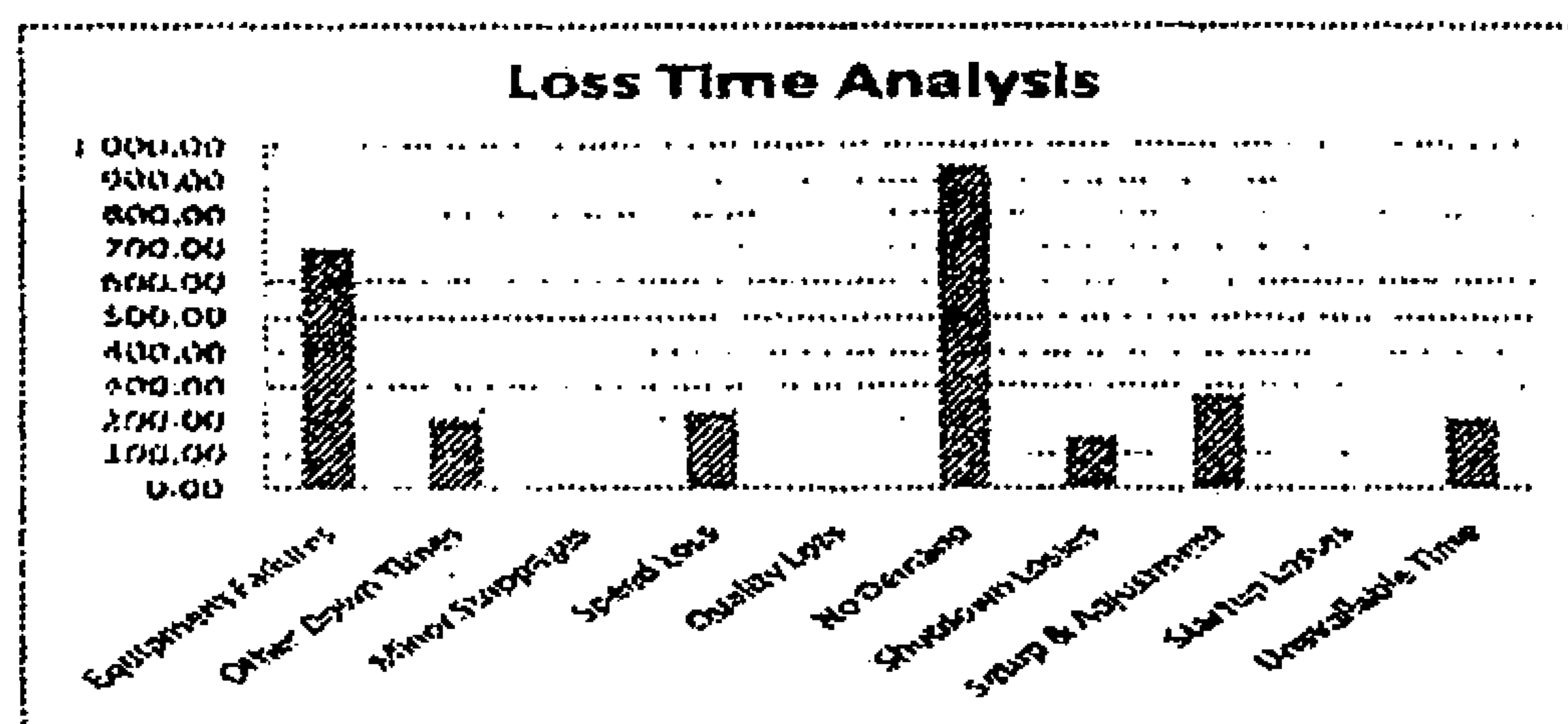


Figure 1.1: Loss Time Analysis

Toothpaste section has only three tubes filling machines. But has 5 toothpaste products with 4 skus. They have done many projects to reduce change over time but failed. They have applied ECRS tool and implemented 'JIG' system to reduce C/O time. According to the mean change over time (August to January) C/O time becomes major problem in the PP department.

According to the Table 1.2, OEE data, productivity is dropped.

Reduced C/O time in 2006	Mean value of C/O time in 2008
32 minutes	168.4 minutes

Table 1.1: Average Changeover Times

	OEE (%)
NM700	57.84
PP Department	59.17

Table 1.2: OEE data

According to the above factors one of major problem in PP department is increasing changeover time. Therefore the main Research Question of this study is identifying if the changeover time is a barrier to improve productivity in PP department.

The study was carried out with the objective of analyzing the changeovers in PP department with the purpose of improving the productivity. To achieve this objective, the study focused on related literature, how changeover time could be a problem, analyzing the working environment, identifying and analyzing the factors adversely affecting to the changeover time and finally give solutions to reduce the changeover time.

LITERATURE REVIEW

The productivity can be defined as a measure of effective use of resources, usually expressed as the ratio of output to input. There are number of factors affecting to the productivity in direct and indirect way in manufacturing and service sector. The productivity factors that affecting to the research are the set up & adjustment time, management commitment and leadership, workplace design, incentive payments, attitudes of workers, efficiency of workers, etc. (Lecture notes 2008, Productivity Techniques).

There is direct relationship between productivity and OEE. The concept of OEE was introduced by a technique TPM. Improve Overall Equipment Efficiency means improve of productivity (TPM text book, TPM centre). OEE is a calculation which focuses on individual items of process or manufacturing equipment and allows their 'effectiveness' to be measured individually or in groups.

Overall Equipment efficiency can define as;

$$\text{OEE} = \frac{\text{Availability} \times \text{Performance Rate} \times \text{Quality products rate}}{\text{products rate}}$$

Availability takes into account Down Time Loss, which includes any events that stop planned production for an appreciable length of time. Examples include equipment failures, material shortages, and changeover time. Performance takes into account Speed Loss, which includes any factors that cause the process to operate at less than the maximum possible speed, when running. Examples include machine wear, substandard materials, misfeeds, and operator inefficiency. Quality takes into account Quality Loss, which accounts for produced pieces that do not meet quality standards, including pieces that require rework. (Inconics, 2006)

TPM is a maintenance program which involves a newly defined concept for maintaining plants and equipment. The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction. According to the TPM there are six types of waste that can refer as losses

as they reflect lost effectiveness of the equipment. These six losses can also group in three categories: downtime, speed losses, and defect losses. Downtime includes two major losses, equipment failures and set up and adjustments. A company needs TPM to avoid Wastages and reduce cost, improve the quality, to improve machine efficiencies, improve motivation and commitment so on. (McCarthy, et al, 2004)

Under setup and adjustment most machine changeovers require some period of shutdown therefore that internal tools can be exchanged. The time between the end of production of the last good part and the end of production of the next good part is downtime (TPM text book, TPM centre). Changeover in manufacturing is the process of converting a line or machine from running one product to another. Changeover times can last from a few minutes to as much as several weeks.

There are number of factors which influence the changeovers. They include ignoring simultaneous changeover activities, behavior of workers, management commitment, location or layout and easy access (McIntosh, et al, 2001). Therefore ignoring simultaneous changeover activities, behavior of workers, management commitment and Hard to Access Areas are affected to the high changeover time. The high changeover time is directly affected to the production time, breakdowns, wastages and equipment efficiency. And finally these factors result to the productivity, profit, quality and OEE of the department.

METHODOLOGY

The research is an applied research since it is undertaken to answer a specific industry problem and give solutions to it. The research is mostly based on qualitative data and applied deductive reasoning. It is the logical process of deriving a conclusion from a know argument and something known to be true. Deductive reasoning is a valid form of proof. It is the process by which the research makes conclusions based on previously known facts.

This research executed two main data collection methods: primary data and secondary data. Primary data were collected through observations and informal discussions. Because of the violent situation in department, it was difficult to apply other sophisticated primary data collection methods. Although primary data collection methods such as formal interviews or questionnaire are effective in similar research, the research could not use them due to prevailing unfavorable situation of the organization. Therefore informal discussions with workers, managers and supervisors were used to collect data. The research uses secondary data too. The production and machine breakdown data were taken from the production sheets.

The details of loss tree data and OEE of the department were taken from the information system. To get past data, project boards, charts, reports, and magazines were used. The user manual of NM 700 toothpaste filling machine was used as a secondary data source. TPM text book was used to gather information that relevant to the research.

As data collection tools the time study, the stopwatch technique was applied. And also digital camera was used to take photographs as data and a table format was used to mark changeover activities and time durations of each activity. Use the mean, standard deviations and Gantt charts as statistical methods.

DATA COLLECTION & ANALYZING

Initially the manufacturing process and layout of the NM700 machine was identified. As shown in the layout (Figure 1.2) there are seven workers assigned for the machine. The changeover time starts when the last product of the batch is produced until the moment that the first product of the next batch is produced. All the changeover activities are identified and changeover time durations for each activity are taken.

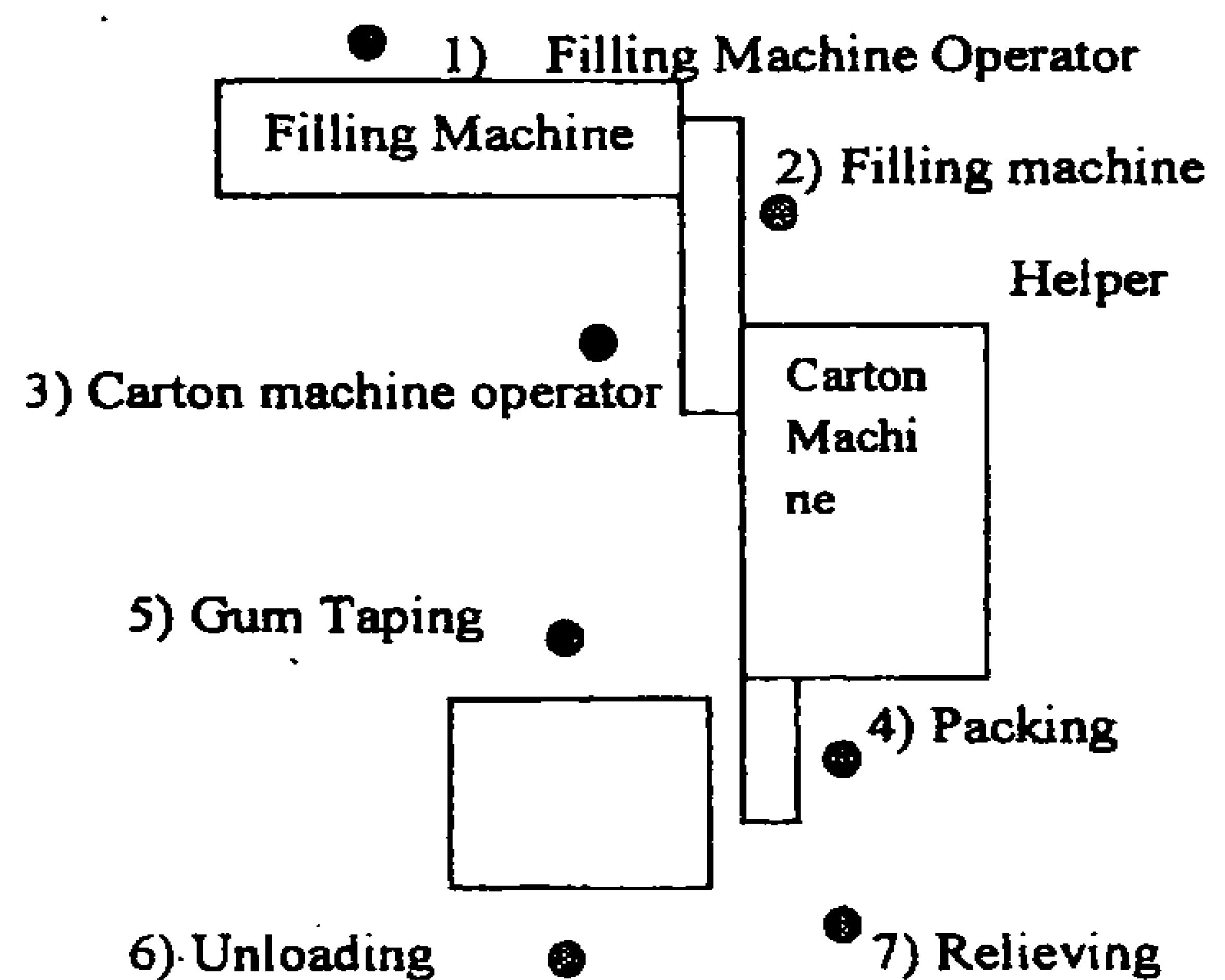


Figure 1.2: Layout of the NM 700 Machine

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Table 1.3 shows changeover steps and average time for each changeover activity.

No	Activity	Avg. Time (min)
1	Change Tube cassette	2
2	Change and adjust rocker plate	5.6
3	Adjust overhead guide plate	3.6
4	Adjust lateral guide plate	2.5
5	Adjust and Change tube tilter	6
6	Adjust and Change side wall	3.5
7	Adjust and Change tube infeed depressor	4.4
8	Adjust sealing unit	2
9	Adjust tube ejector	2.5
10	Change tube holders	6
11	Adjust and Change white filling unit	9.4
12	Adjust tube registration photocell	2
13	Adjust and Change red filling unit	7.2
14	Change hot air unit	5.4
15	Adjust product transport chain	1.7
16	Adjust product pushes	15
17	Adjust overhead guide rail	8
18	Adjust carton transport bed	3.9
19	Adjust carton transport chain	8.8
20	Adjust carton magazine	9
21	Adjust & change carton erection	7.2
22	Adjust side flap folding swing arm	2.5
23	Adjust end flap guide rail	6
24	Adjust front flap folding bar	7.2
25	Adjust triangular folding rail	6
26	Adjust tuck-in flap guide plate	4.6
27	Adjust horizontally rotating carrier plate	5.4
28	Adjust flap closing finger	3.9
29	Cleaning the environment & machine	21.5
30	Replace carton & empty tube boxes for new product	11.9
31	Testing & re-adjustments	16.5

Table 1.3: Average times for changeover activities

There are seven workers assigned for the line. During the changeover there should be at least five workers and one fitter. According to the researcher observations, when changeover going on there are only two or three workers. Sometimes even the main operator is not in the line when changeover going on. There were no more than three workers in the line at any time.

By using Gantt charts and changeover process the changeover activities and time details can be analyzed.

There should be two Gantt charts for the filling machine & the carton machine, since activities of these two are independent. According to Figure 1.3 Gantt chart there are simultaneous activities and the filling machine changeover process can be finished within 32.1 minutes. According to Figure 1.4 Gantt chart carton machine changeover process can be finished in 36.9 minutes. These two sections are independent and because of the concurrent activities total changeover time increased up to 36.9 minutes. Following Gantt chart shows the overall change over process and total times. According to Figure 1.5 Gantt chart total changeover time is 53.4 minutes.

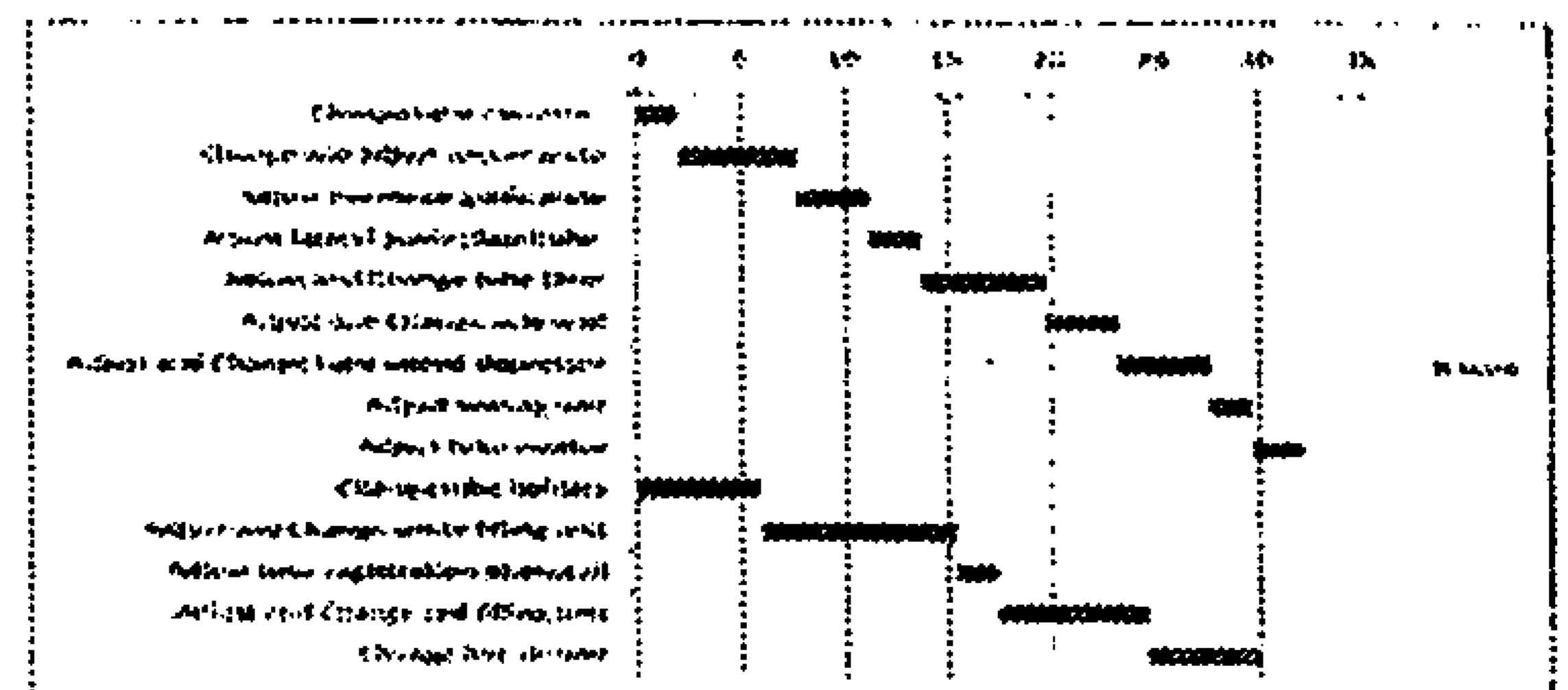


Figure 1.3: Gantt Chart for filling machine

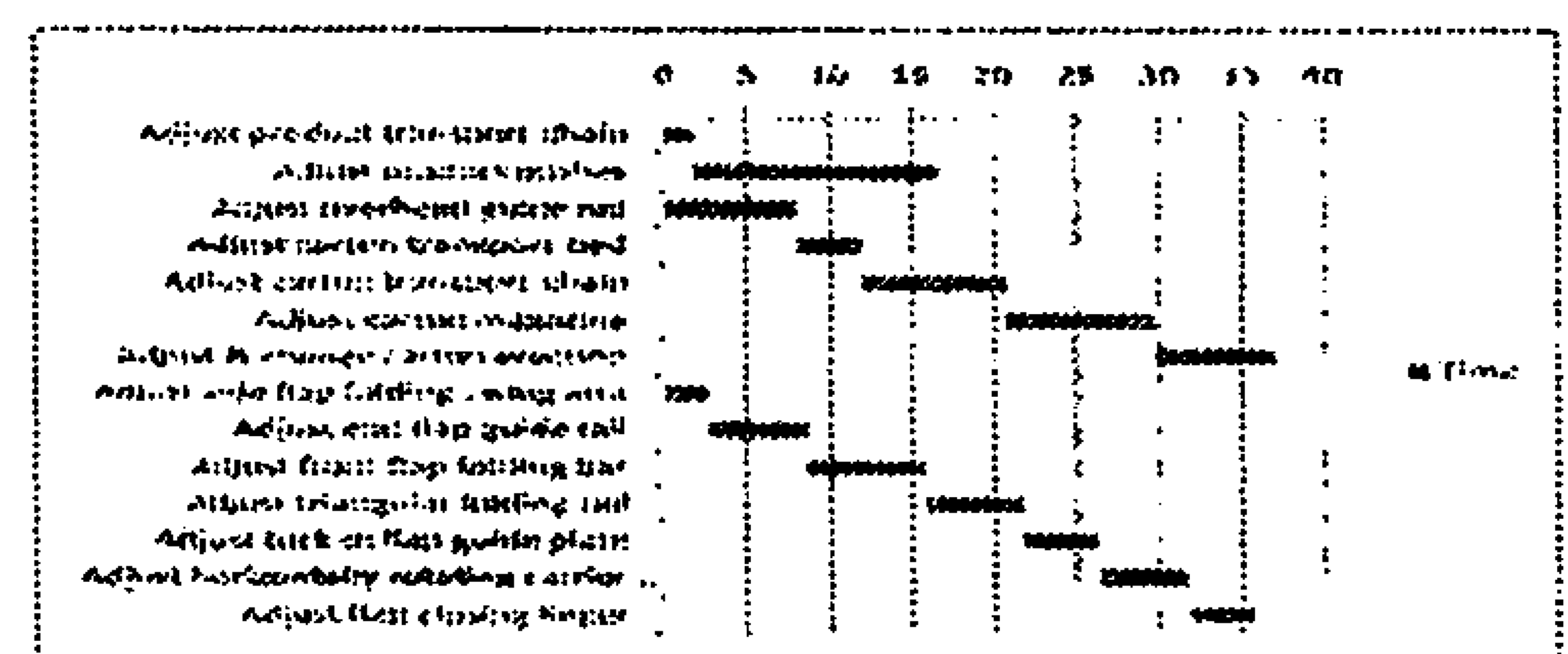


Figure 1.4: Gantt chart for Carton machine

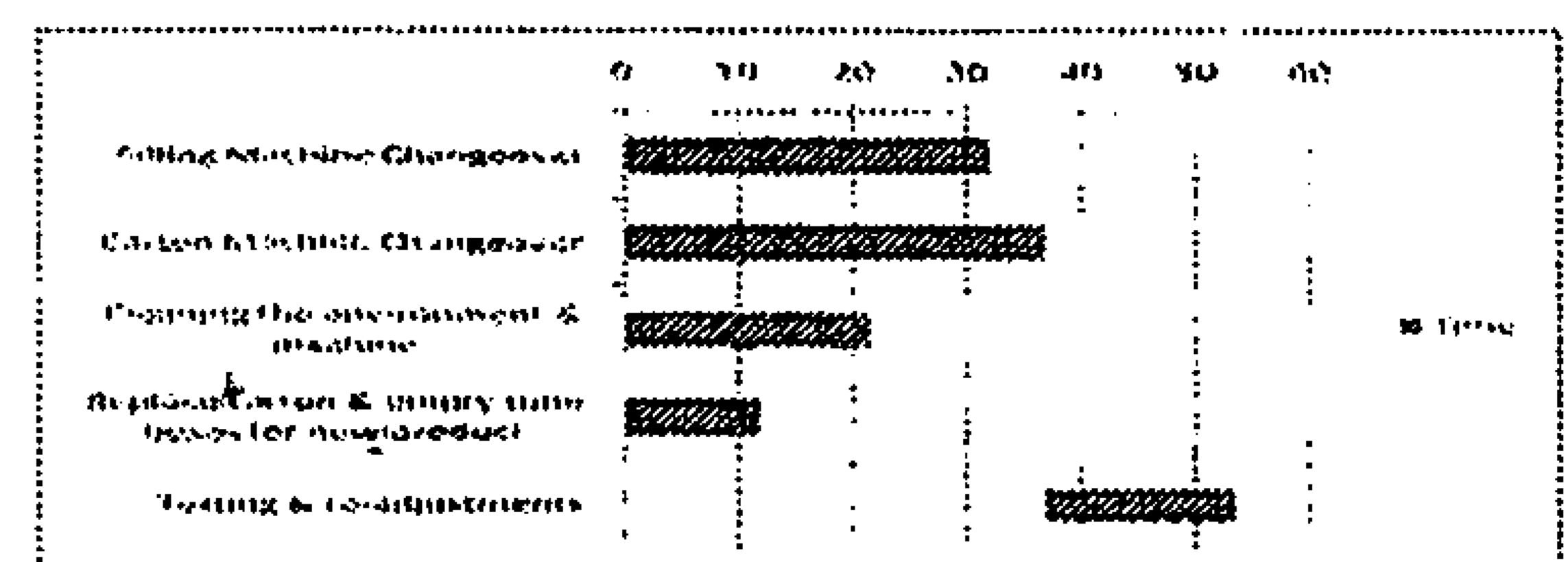


Figure 1.5: Gantt chart changeover NM700 machine

Using above analysis the changeover activities can be identified on their interrelationship. There are consecutive activities that mean that a certain setup activities are always followed by another changeover activity. Those activities are shown clearly in Figure 1.5 and there are disjunctive activities that have no relation with other changeover activities. In the Gantt charts those activities are initially started. Therefore using above analysis these activities can be done simultaneously while the changeover going on.

There was no specific supervisor in the line. Therefore the changeover process does not any administration. Even the management rarely visits to

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production floor and direct the changeover. If the changeover going on night shift there is no control at all. In those situations changeovers get around 4 to 5 hours.

Following information about changeovers were gathered using the informal discussions with the management

- The workers consumed more time for changeovers because their interest on overtime.

- The PP managers are always busy with meetings and they have to consider the production targets, quality and safety of the plant.

Following information was gathered according to the informal interviews with workers.

- The top management is going to move the factory from Grandpass to Horana in 2010 with half of the workers. Thus workers are frustrated and they are not willing to work properly.

- The workers think managers are not concerned about the plant & they haven't monitored the machines and equipments. Although they inform about the failures about the machines the manager are not concerned over them.

- Workers' attitude regarding to reduce changeover time is not that much positive. Their attitudes & perceptions are that reducing changeover time means it won't be done properly.

According to the behavioral observations and using informal discussions, in the PP department there is no good relationship with management and workers. Thus to do the changeover effectively and efficiency there should be motivation and there should be good attitudes and perception towards the department and the company. There should be good working environment to do a better job. The information of moving the factory to Horana had made workers to undergo stressful attitudes. The workers fear that this can lead to lose their jobs. Because of this stressful situation there were conflicts between the workers and the management. Therefore the conclusion the researcher get that there is no job security and good working environment and interest to work according to workers side. This lead to decrease the motivation and that directly affects the changeover process. When the workers' attitude and perception towards the changeovers are analyzed the researcher assumes that they are wrong. Their idea is quick changeovers result the improper changeovers. They don't know the actual thing behind the changeovers and the importance of them. Therefore those attitudes of workers also directly affect the changeover time.

With the situation in the PP department, the management also works in a very stressful environment. Mainly they have to attend several meetings a day, should consider safety and quality of the department, should achieve the production targets and should handle the grievances of workers. The PP department as the largest department in the company, there is a Plant manager, a junior manager, an Engineer, an Engineer Assistant and shift leaders. But to achieve production target the plant manger's responsibility is to monitor the changeover by any mean. The management has a great influence on the quality of the changeover. The plant manager has to prioritize the necessary of short changeovers. That will lead to reduce the changeover inefficiencies and also it is manager's responsibility to give orders to take necessary packing materials. Otherwise the workers have to wait until those materials are brought in the changeover time.

RESULTS AND DISCUSSION

According to the analysis there are many factors discussed which cause high changeover time in the PP department. The changeover process in NM700 filling machine and carton machine is discussed by identifying the activities and their sequences in the changeover analysis. By analyzing changeover activity times and using Gantt charts it is proved that those activities can perform simultaneously and hence can save the more time. Earlier the changeover process took average time 168.4 minutes. If changeover activities made parallel, the average time will take 53.4 minutes. 115 minutes of average time can be saved using these parallel activities according to the analysis. Workers morale and situation in the department and the company have directly affected to the changeover efficiencies as the analysis depicts and also the analysis shows lack of management commitment towards the changeover which is also a critical factor. Without monitoring changeover the changeover efficient and time cannot be achieved.

By identifying the root causes to these factors and giving solutions the changeover time in the department can be reduced. As discussed in the Literature review, changeover time is a down time type and reducing changeover time means reducing the down time. Because of reducing down time, availability is increased. Availability is directly proportional to the OEE. So by increasing availability, the OEE can be increased. OEE increased in the NM700 machine indicates productivity increase in the department. Finally it can be said that changeover time is a barrier to improve productivity in the department.

Here is the list of solutions that can be applied for above identified factors to reduce the changeover time.

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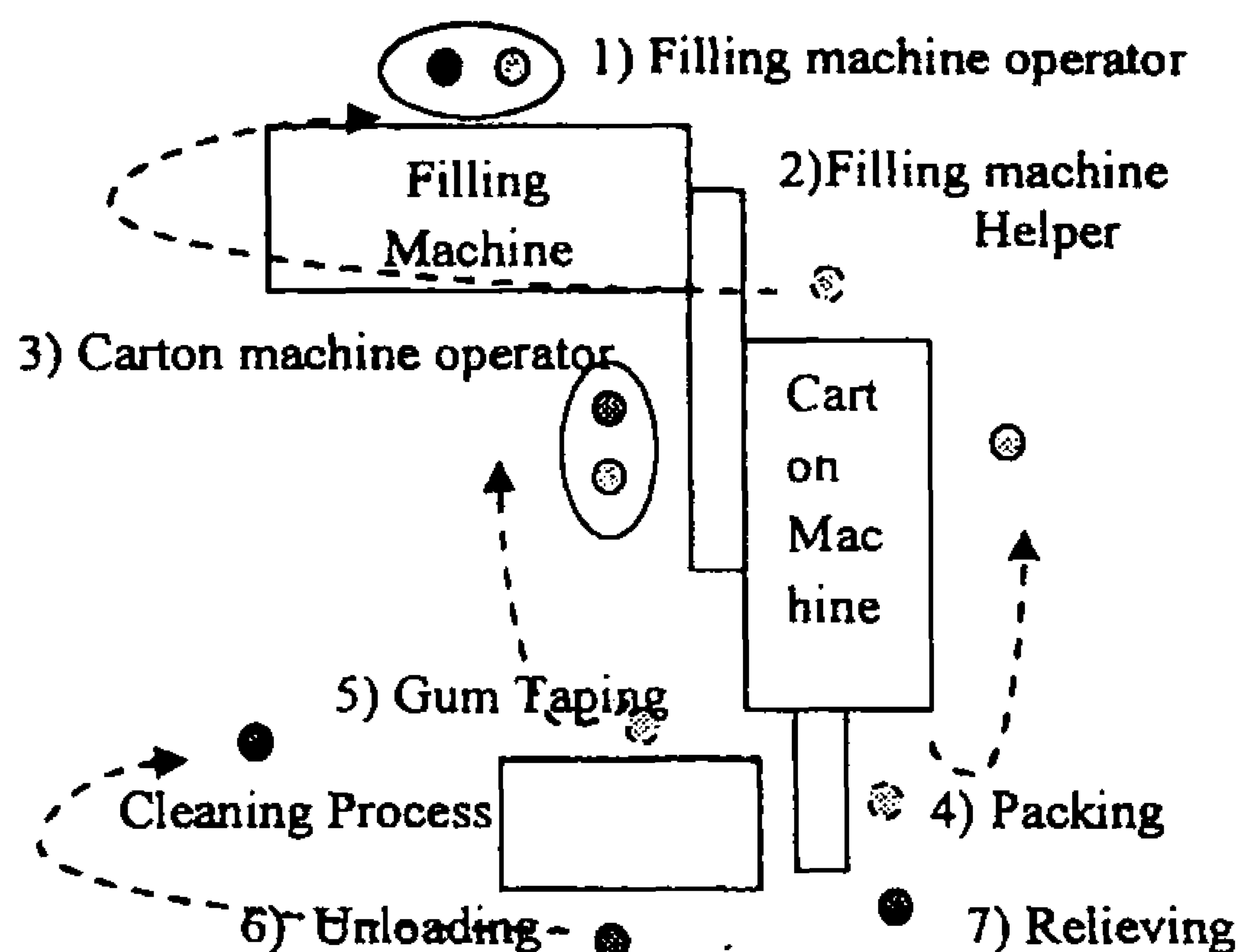


Figure 6.1: Labors at the Changeover

- In the analysis it was identified what are parallel activities that can be done and their sequences. So workers can be assigned for each set of the activities and can save the time.

- With the activities identified, Standard Operation Procedures (SOP) can be made.

- Change workers attitudes and increase the working morale of them by organizing training and development programs

- Improve the management commitment to the changeovers by assigning supervisor in line to monitor whole production and the changeover process. Management may organize meetings and doing discussions about the changeover issues and their other problems too. By that the relationship between management and workers can be enhanced.

- Improve motivation of workers by organizing Interdepartmental Kaizen competitions and by increasing the incentive payments of the company

According to the above details, solutions can be prioritized according to the importance, time constrains, sequential of the solutions, financial constraints. According to the above prioritization, immediate feasible solutions are division of labor for changeovers, assign the tasks and preparing the SOP, organizing training and development programs and appoint supervisor to the line. As the long term solutions can be organized kaizen competition and evaluated the workers skills.

CONCLUSION

The conclusion of the research is that changeover time is identified as productivity barrier in the PP department. The research identifies the behavioral factors

that affect to the high changeover time and the solutions. Therefore the objectives of this research are achieved. The behavioral factors that affect to the changeovers are simultaneous changeover activities, workers attitudes and behaviors and management commitments towards the changeovers.

These factors affect the changeover time and changeover time affects the production time, breakdowns, wastages and equipment efficiency. Therefore these factors directly affect the productivity of the PP department.

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